

Presentation Outline

- Introduction
 - mode awareness
 - approach
 - theory/methodology
- Case study 1
 - vertical A/P modes
- Means of compensation
 - display augmentation

Formal Analysis of Human-Automation Interaction

The Problem of Display Correctness

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Mode Awareness

- Operational
 - field data
- Training
 - teaching AFCS modes
- Procedures
 - custom AFCS procedures
- Regulatory and Certification
 - Abbott et al.

Industry/Research contributions

- **Field studies**

- Wiener, 1985, 1989; Degani, 1996

- **Experimental studies**

- Sarter and Woods, 1992, 1994, 1997

- **Incident analysis**

- Rogers et al.; Mangold and Eldredge; Vakil et al.

- **Cognitive studies**

- Irving et al.; Hutchins; Javaux and de-Keyser

- **Training**

Analysis of Human-Machine Interfaces

■ Assumptions:

- machine behavior is given
- control panel is given
- “perfect” pilot
- task specification and activities are given

■ Display correctness aspects

- quantitative (what info.)
- ↑ Focus
- qualitative (how this info. is displayed)

Research Objectives

- Develop methodology for evaluation of display correctness
 - consistency with training materials
- Develop methodology for display synthesis
 - correct
 - succinct
 - reliable

Approach

- Analytical
 - theory
 - methodology for evaluation and synthesis
- Systematic
 - formal
 - model based
- Specification driven
 - specified activities

- For every situation, where are we on the list?

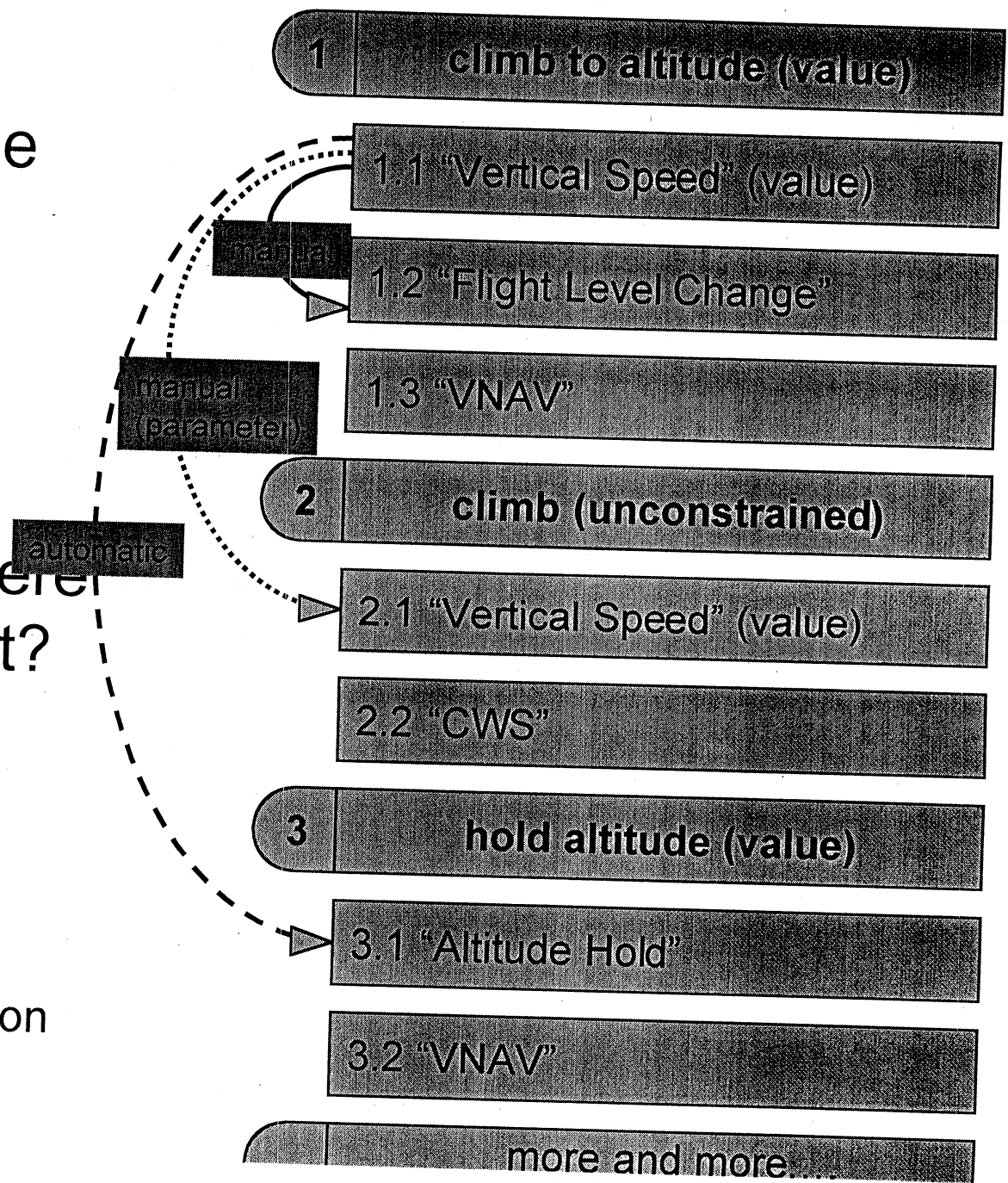
- mode
- parameters

- For every possible pilot interaction, where *will* we be on the list?

- mode
- parameters

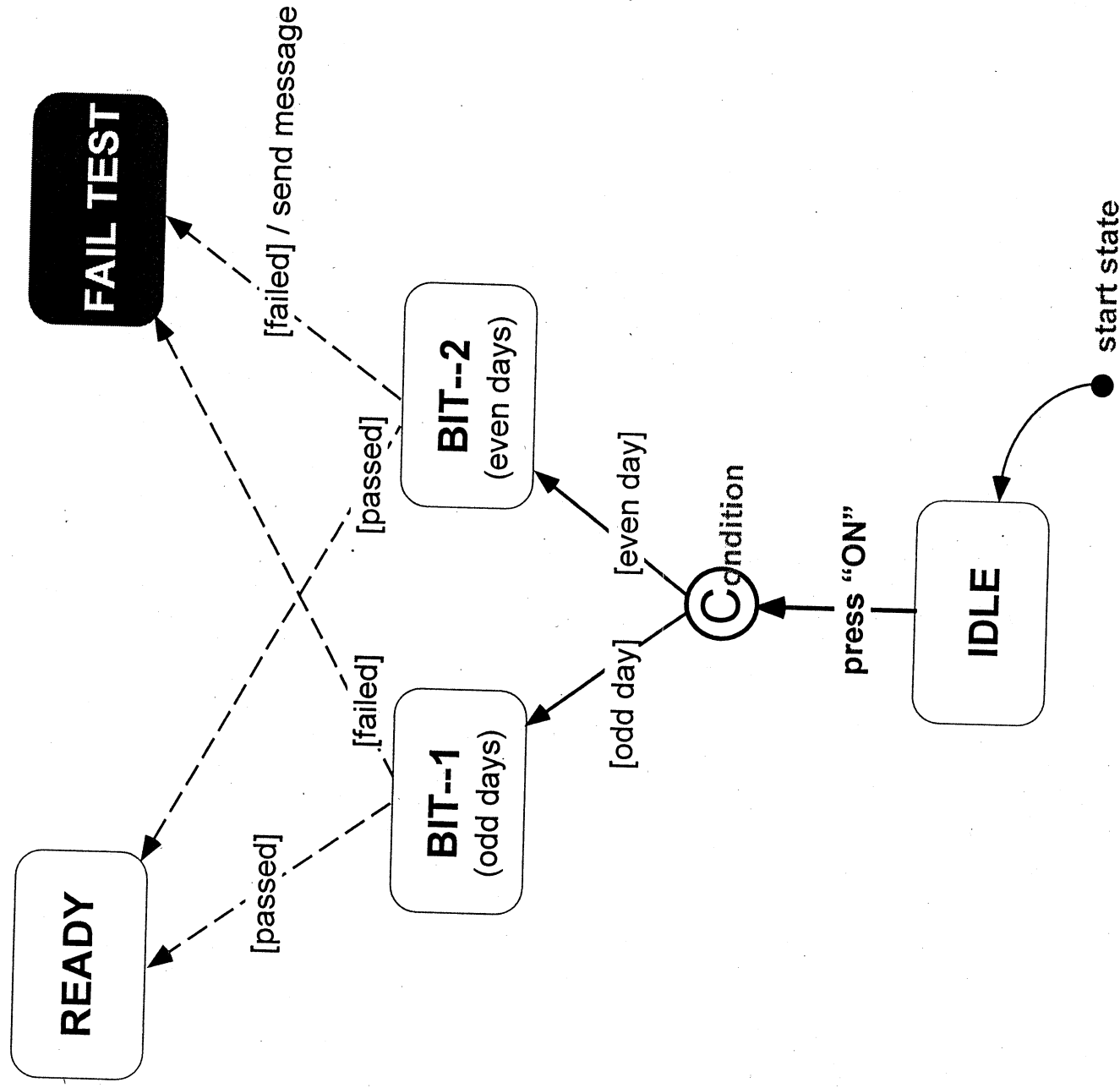
- For every possible pairs of activities, what pilot interaction is necessary to transition between the pair?

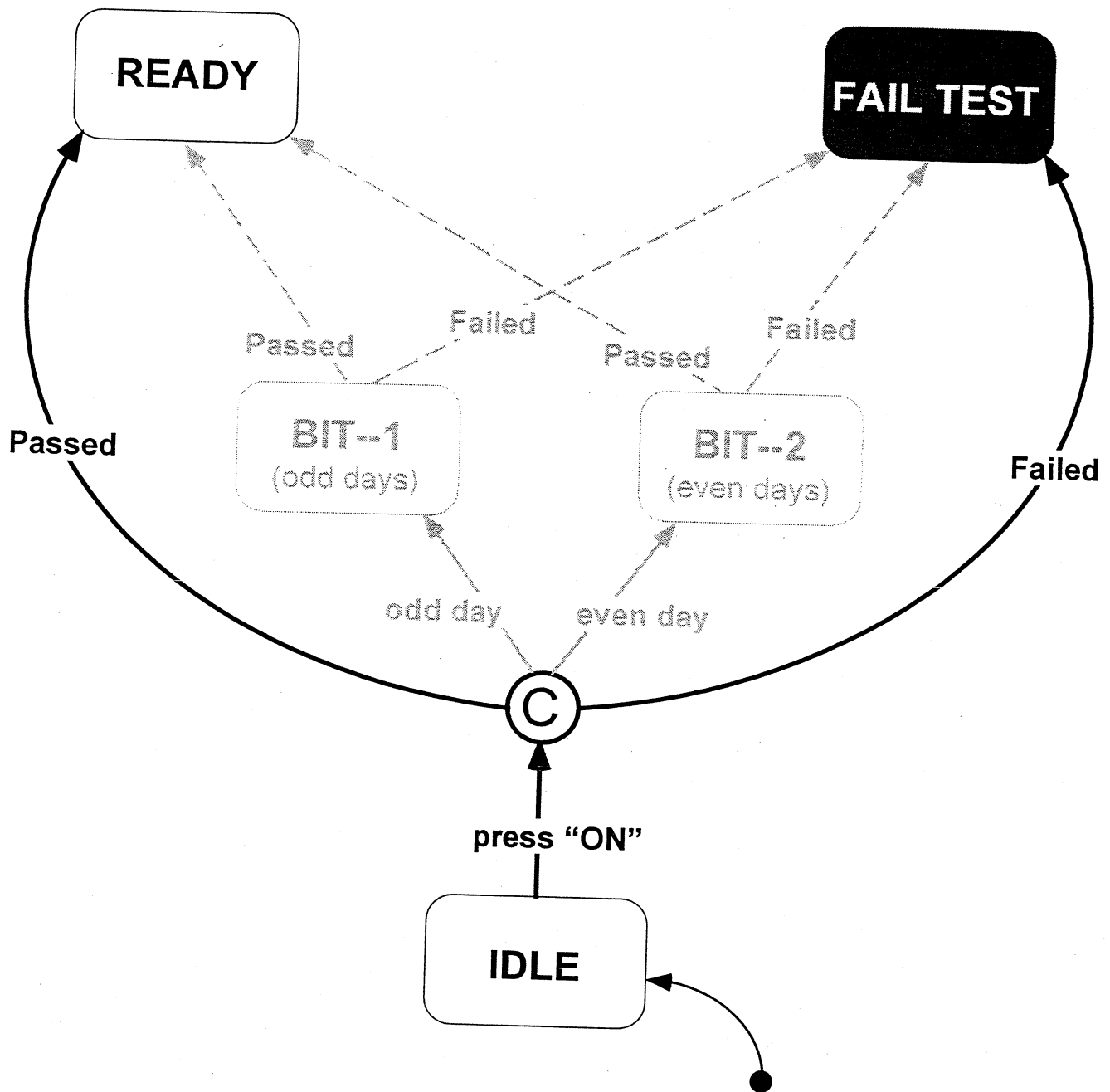
specified activities



Modeling

- Hybrid machine representation
 - discrete
 - continuous
- Confine the investigation
 - system under study
 - related events
- Reverse Engineering
 - Simulator behavior





Flight Guidance Project

- Is display correctness an existing problem?
- Is our theory/method useful?
- Case studies
 - vertical A/P modes
 - “altitude intervene” function
 - electrical system...

Vertical A/P modes

- Existing system
 - VS, FLCH, ALT_ACCQ, ALT_HLD
- Field data
 - ASRS reports
- Concept of display correctness
 - climb/descent to an altitude
- -> proposed solution

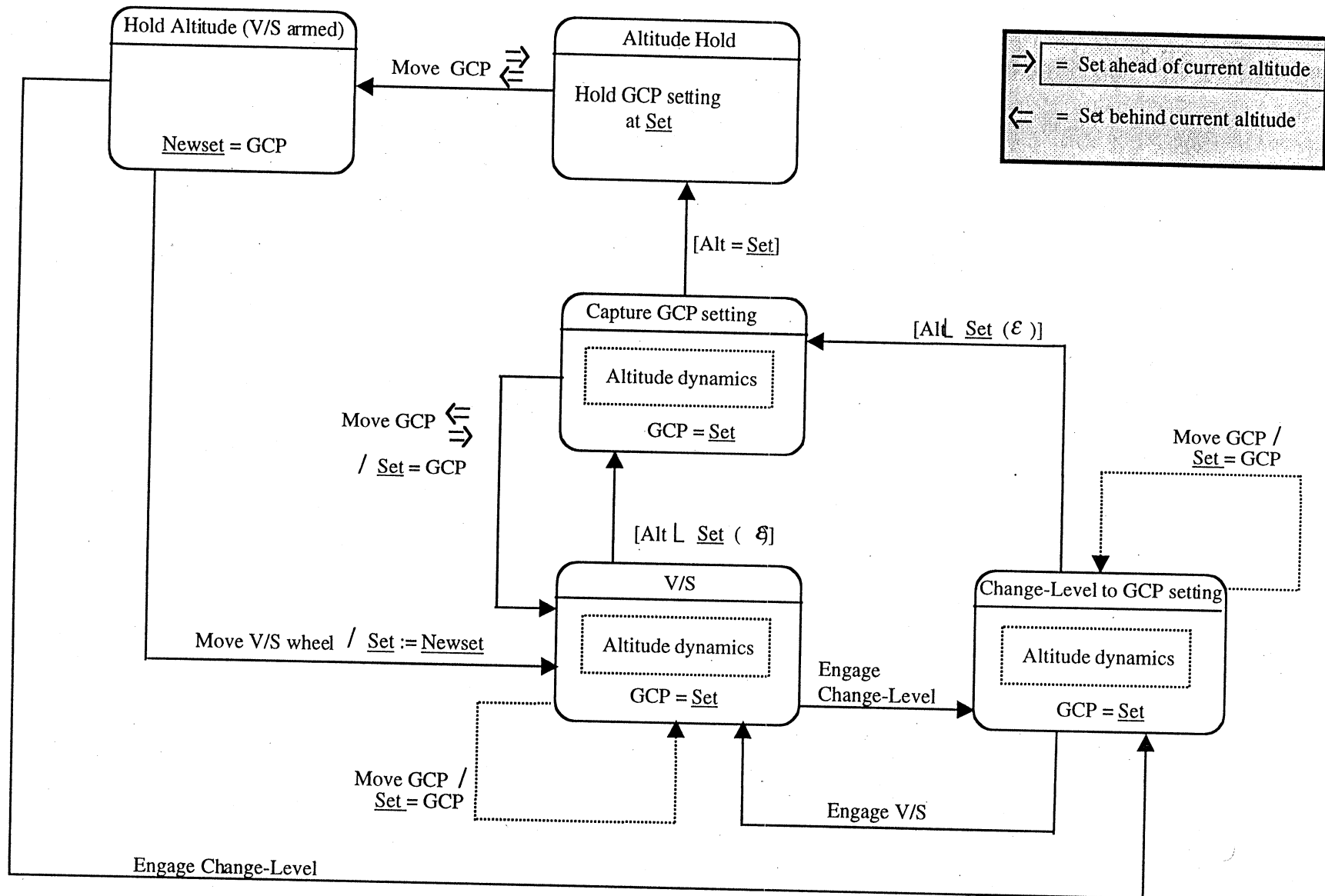


Figure : Vertical Mode Control Model - Training Manual Version

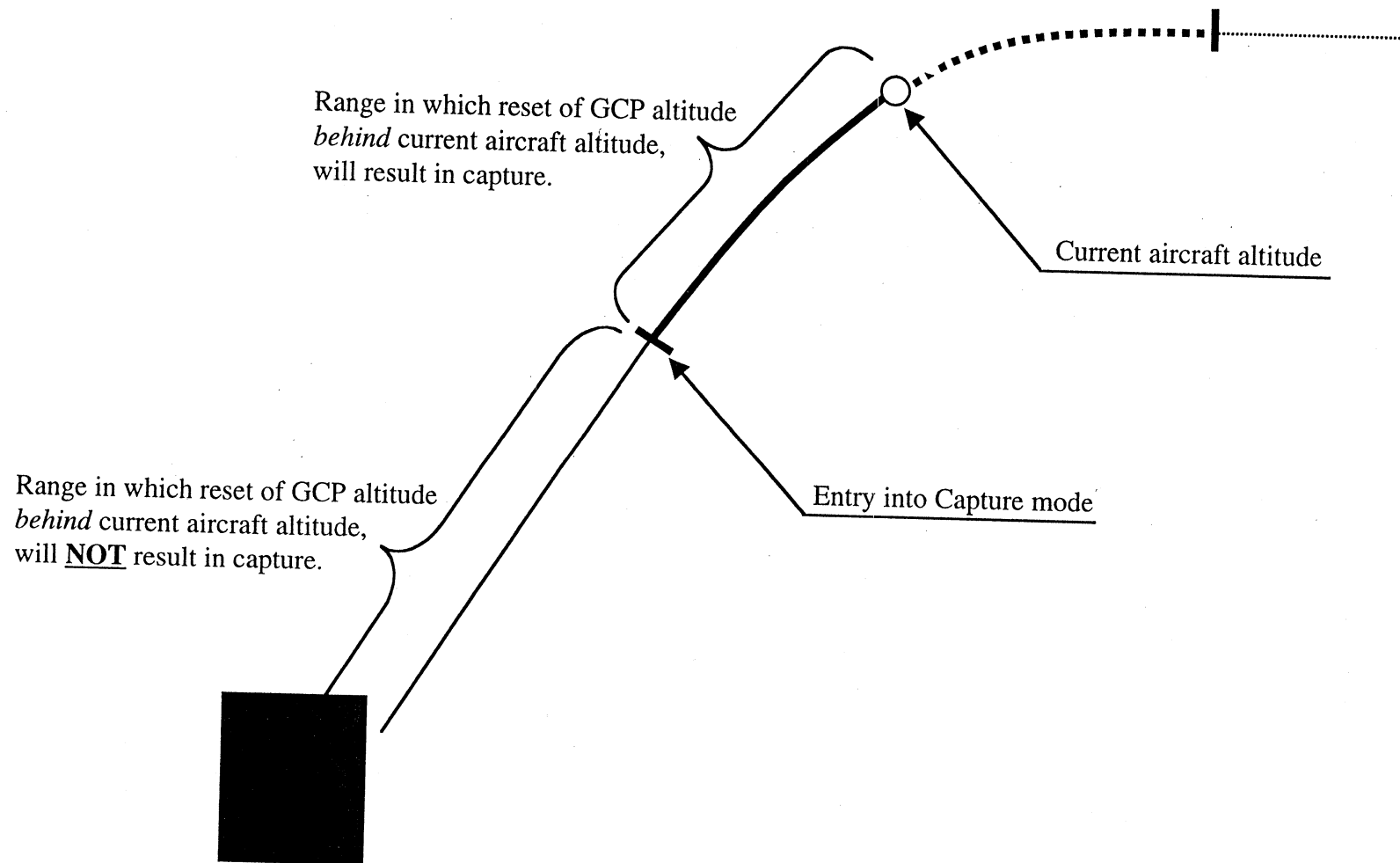


Figure : Capture Profile

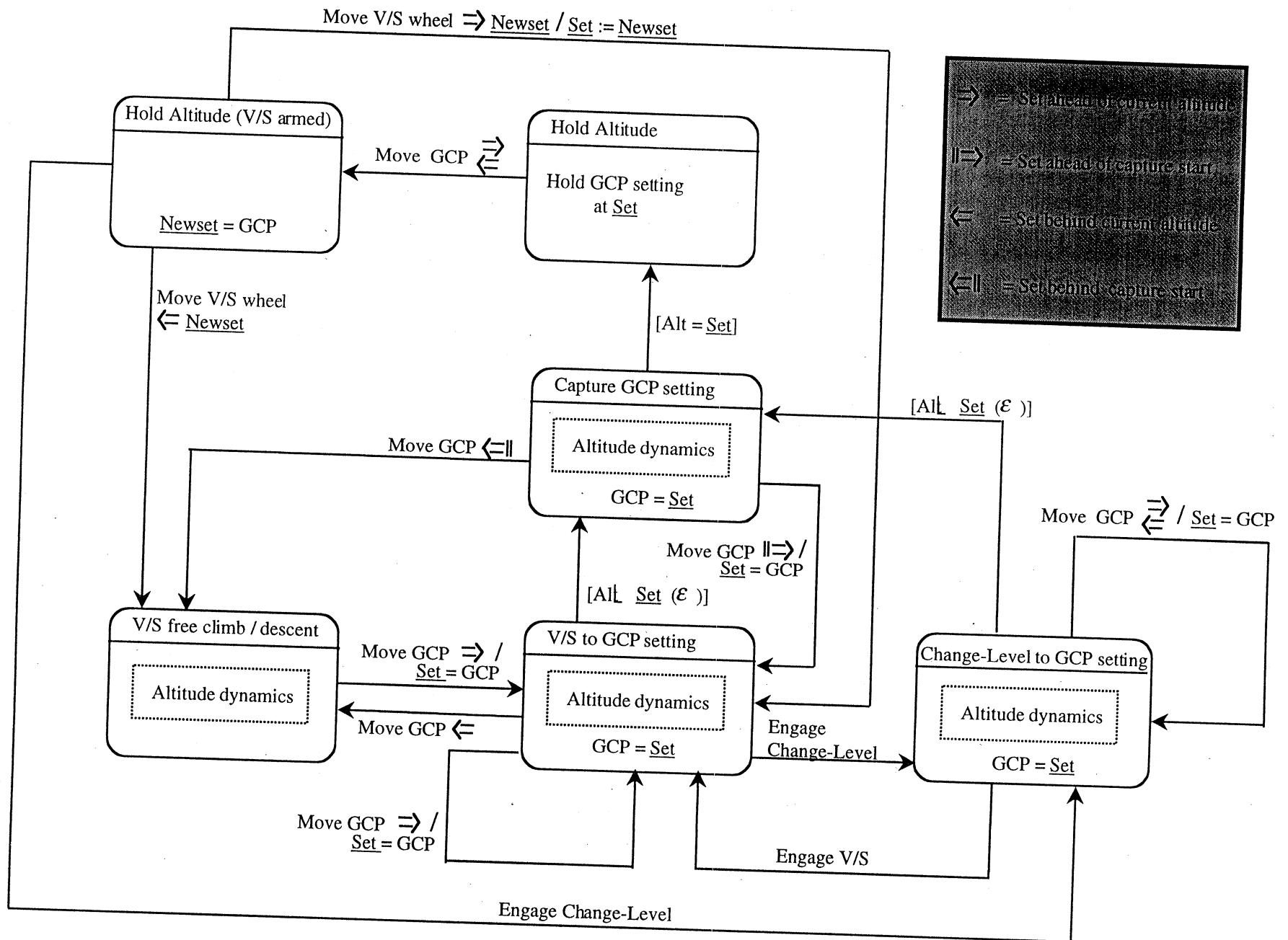


Figure : Vertical Mode Control Model - Actual

Altitude Intervene

- Introduction of *new* function into AFCS
 - focused analysis
- Field data
 - none
- Process of doing an evaluation
 - profile
 - model
 - analysis

Process of Evaluation

- Profile
 - climb, cruise, descent
- “Altitude Intervene”
 - no MCP contradiction
- “Altitude Intervene”
 - with MCP contradiction
- -> proposed solution

Limitations

■ Entry assumptions

- machine is fixed
- “perfect pilot”
- display format and layout
- crew factors

■ Modeling

- state explosion problem
- input events
- hybrid systems are not well understood

Conclusions

- Theory
- Methodology
- Examples
- Process of evaluating human-automation interaction

A step in the search for a quantitative method for evaluating autoflight displays